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out properties of the differential equations (3) and (4). For example, it is very easy to determine, when the type of the vector is known, whether these equations can be solved by quadratures. Again, it appears that the most general equation (4) never corresponds to the vector function of the most general type, but to a slightly restricted type. A consideration of the details of these normal forms would carry the discussion beyond the limits of the present paper.

¹ W. R. Hamilton, *Lectures on Quaternions*, p. 480.

² Arthur Cayley, *London, Phil. Trans. R. Soc.*, **48**, 17 (1858).

³ Hermann Grassmann, *Gesammelte Werke* (Die Lineale Ausdehnungslehre, 1844, § 172).

⁴ Gibbs-Wilson, *Vector Analysis* (1902). A dyadic is a sum of dyad terms, where each dyad is a product of two vectors. When multiplied into the vector ρ by dot, i.e., scalar, multiplication, a single dyad is equivalent to a Hamiltonian term of the form $\beta S \alpha \rho$.

⁵ W. Voigt, *Die fundamentalen Eigenschaften der Krystalle* (1898).

⁶ Hamilton, *loc. cit.*, Lecture VII. A Hamiltonian invariant is a function of three vectors which is unaltered when these vectors are varied.

⁷ Darboux, *Mémoire sur les Equations Différentielles Algébriques*, *Bul. Sc. Math., Paris*, **13**, 83 (1878).

⁸ Clebsch, *Leçons sur la Geometrie* (Tr. Benoist), t. 2, p. 113; *Vorlesungen über Geometrie*, Bd. 1, 390, 1001.

⁹ Hamilton, *Elements of Quaternions*, Art. 415.

¹⁰ F. L. Hitchcock, *Phil. Mag.*, Ser. 6, **3**, 576 (1902); *Ibid.*, **4**, 187 (1903).⁷

ON THE RADIAL VELOCITIES OF FIVE NEBULAE IN THE MAGELLANIC CLOUDS

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In the course of observations on the velocities of approach and recession (radial velocities) of southern nebulae whose spectra contain bright lines, made with spectrographs attached to the 37-inch reflecting telescope of the D. O. Mills Expedition from the Lick Observatory, at Cerro San Cristobal, Santiago, Chile, we have found that the following five nebulae have high radial velocities. The results depend upon the observed positions of the $H\beta$ hydrogen line and the nebulium lines at 5007A and 4959A, in each case. The velocities are not corrected for the solar motion.

Nebula	Right ascension	Declination	Radial velocity km/sec.	Number of plates
N. G. C. 1644	1h 6.2m	-73° 44'	+158	3
N. G. C. 1714	4 52.0	-67 06	+301	2
N. G. C. 2111	5 52.6	-69 33	+268	2
N. G. C. 1743	4 54.6	-69 21	+254	1
N. G. C. 2070	5 39.4	-69 09	+276	1

It is of special interest that all of these nebulae lie in the Magellanic Clouds, and that they are the only nebulae thus far observed by us in the Clouds. The first object, N. G. C. 1644, is in the Smaller Cloud, and the other four are in the Greater Cloud.

It is difficult to doubt that these nebulae are actually within the structure of the two Clouds, respectively: N. G. C. 1644, seen upon the Smaller Magellanic Cloud as a background, is the only known bright-line nebula in that region of the sky;¹ and the others are four of the nineteen known bright-line nebulae closely clustered upon the background of the Greater Magellanic Cloud, which are almost equally isolated from other nebulae of their kind.

Again, the radial velocities of the four nebulae observed in the Greater Cloud lie between 250 and 300 km. per second, recession. We should not expect the substantial equality of such high velocities unless the four objects bear a close relationship to each other or to the structure of the Greater Magellanic Cloud as a whole. It seems desirable that an effort should be made to measure the radial velocities of as many of the faint stars in the Magellanic Clouds as time and means will permit, in order to determine whether the average velocities of the stars in the Clouds approximate the velocities of the nebulae existing in the Clouds; that is, to determine whether the Magellanic Clouds possess high velocities of recession with reference to our general stellar system.

One is also inclined to inquire whether a more or less intimate resemblance may exist between the characters of the Magellanic Clouds and of the spiral nebulae, inasmuch as the spirals have been observed by Slipher to possess abnormally high radial velocities.

¹ For list of nebulae known to have bright-line spectra, see *Annals of Harvard College Obs.*, 76, 21 (1914).

NOTICES OF SCIENTIFIC MEMOIRS

Monograph of the Bombycine Moths of North America, including their Transformations and Origin of the Larval Markings and Armature. Part III. Families *ceratocampidae* (exclusive of *ceratocampinae*), *saturniidae*, *hemileucidae*, and *brahmaeidae*. By ALPHEUS SPRING PACKARD, edited by THEODORE D. A. COCKERELL. First Memoir of Volume 12 of the Memoirs of the National Academy of Sciences. Washington, 1914. 1-502 p. 34 fig. 113 pl.

The third part of the late Dr. A. S. Packard's *Monograph of the Bombycine Moths of North America*, published on December 31, 1914, by the National Academy of Sciences, and containing 16 pages including 34 figures and 113